REMARKS

The interview conducted on December 13, 2005 with Examiner Carrillo and assignee's attorney, E. Bradley Gould, is sincerely appreciated. The discussion during the interview is reflected in the comments below.

Claims 1-5 and 11-28 are presented for the Examiner's review and consideration. Claims 1, 16, and 25 are currently amended and claims 26-28 are newly added.

The amendments to the claims are fully supported in the originally filed specification, claims, and drawings. For example, the amendments to claims 1, 16, and 25 concerning the treating of the substrate in a bath and exposing it to gaseous ozone being conducted within a closed container, are clarifications of the original claim language. New claim 26 is supported, for example, in paragraph 4 of page 4; claim 27 is supported, for example, in this same paragraph and in paragraph 4 on page 6; and new claim 28 is supported, for example, on paragraph 5 of page 6 and Fig. 6. No new matter has been added by the present amendments.

In the Office Action, claims 1, 16, and 25 were rejected under35 U.S.C. 112, second paragraph, based on the use of the term, "adhesive." Although this term is still believed to be definite and that its meaning would be clearly understood by one of ordinary skill in the art, to facilitate the prosecution of the present matter, the claims have been amended instead to eliminate the use of this term, referring to the recited surface as being dry and hydrophilic. This rejection is thus believed to be overcome.

Claims 1, 2, 5, 11, and 25 were rejected under 35 U.S.C. 102(e) as anticipated by Hishiya. Claim 1 is directed to a method for producing a dry, hydrophilic surface on a substrate to improve its subsequent bonding to another substrate. The method includes treating the substrate surface, which includes an oxide layer, by a wet chemical etching process, that removes the oxide layer and provides a hydrophobic surface. The wet chemical etching process is directly followed by exposing the etched hydrophobic surface to a gaseous ozone atmosphere to provide a dry hydrophilic surface that enhances subsequent bonding to the other substrate. These two steps, namely the wet chemical etching and the exposure to the gaseous ozone, are conducted within a same closed container. Claim 25 recites similar steps, but includes the transition phrase, "consisting of."

The Hishiya reference, on the other hand, is not concerned with providing the dry hydrophilic surface for bonding to another substrate. Instead, Hishiya is directed to

forming an oxide film (*see* Hishiya [0005] and [0023].) Additionally, while Hishiya teaches treatment with an HF solution to remove oxides that are present on the surface of the wafer before the protective oxide film is formed (Hishiya [0070]), an ozone treatment step is not conducted directly after the HF treatment and cannot be conducted in the same container as the HF treatment due to the other requirements of the method of the teaching. Specifically, Hishiya explains that a pre-treatment process follows the HF treatment, including a loading operation in which the wafer is loaded to be positioned in a reaction vessel of the oxidation treatment apparatus. (Hishiya [0074], [0075], and [0079], *et sec.*)

In the presently claimed invention, conducting the chemical etching bath and exposure to the ozone atmosphere in a single container provides the surprising advantage over Hishiya, of very significantly reducing or minimizing the recontamination of the surface following the bath, which can provide a far improved uniformity of the dry hydrophilic surface compared to methods in which the bath and exposure to the ozone atmosphere are conducted in separate containers. Using separate containers requires transferring the substrates from one container to the other. Due to the hydrophobic nature of the surface after the bath they are especially susceptible to contamination with foreign particles, which would compromise the bonding qualities of the surface after exposure to the ozone atmosphere. The resulting inventive surface has significantly improved bonding characteristics and produces a stronger bond to the other substrate compared to the prior art due to the lack of contamination by contaminants that would reduce the surface quality and render it more uneven. As explained in the specification, such as in paragraph 4 on page 3 and paragraph 2 on page 4, the ability to bring the etched surface of the substrate from the bath directly to the gaseous ozone in the same container is what allows the recontamination of the extremely sensitive surface to be prevented.

There is no suggestion of the claimed method or of such advantages in Hishiya, which is concerned with forming an oxide layer. Since the desired qualities of the surface provided by the present invention are far more sensitive to contaminants than the oxide surface provided by Hishiya, there is not the same need to modify Hishiya in a manner that would make its method more complex just to reduce contamination beyond what is normally achieved using traditional methods in the art. Finally, any modification of Hishiya to conduct its several steps within a single container is not readily achievable, nor is there any indication on how this could be readily achieved, since the various vessels used in Hishiya are disclosed to provide additional processes to the wafer before exposure to the ozone.

Furthermore, the Hishiya teaching is not directed to conducting any method to provide a dry hydrophilic surface that can improve bonding to another substrate. As stated above, Hishiya is merely directed to providing an oxide film.

With respect to claim 25, Hishiya conducts additional steps interspersed with the claimed steps, which are specifically excluded due to the "consisting of" transition language used. Claim 25 thus represents a preferred embodiment which facilitates obtaining good results for surface preparation for improved bonding.

Consequently, claims 1 and 25 are neither suggested nor obvious over Hishiya.

Claims 13-16, and 20-23 were rejected under 35 U.S.C. 103(a) as being obvious over Hishiya in further view of Geusic. The method in claim 16 includes the immersing of the substrate into an HF bath, directly followed by the exposure to the gaseous ozone, both of which steps are conducted within a closed container. This claim, similarly to claim 13, further defines the bonding of the resulting dry hydrophilic surface to the surface of another substrate. Claim 14 further specifies the range of increased bonding strength that is easily achievable by the recited method, and claim 20 recites conducting the same treatment to the other substrate which is bonded to the first recited substrate.

Geusic, however, does not remedy the deficiencies of Hishiya. The Geusic process includes dipping silicon wafers in HF solution. (Geusic 5:21-23.) After this dipping, Geusic provides doing one of two things with the hydrophobic surfaces. A first alternative is to initially bond the surfaces to each other at room temperature and atmospheric pressure, taking advantage of van der Waals forces. These wafers are then intended to be separated into two wafers again for further processing. (Geusic 5:27-49.) A second alternative is to store the wafers in an ultra-clean environment prior to introduction into a vacuum chamber. (Geusic 5:51-54.) Both of these alternatives are conducted to retain the cleanliness of the wafer surfaces that are to be annealed. (Geusic 5:55-56.)

As can be seen by this disclosure, Geusic does not foresee conducting an ozone exposure directly following an HF bath in a single container, as recited in claim 16, and the Geusic teaching would be very difficult to modify to conduct these in a single container, since it requires either bonding the substrates in a specialized separate machine, or keeping them in a separate type of atmosphere, which is not an ozone atmosphere. In fact, these alternative steps of Geusic teach the opposite from conducting a bath and an exposure to an atmosphere in a single container.

The surprising advantages of the present invention, in which the highly improved bonding surfaces are provided with far decreased likelihood of contamination and a far simplified procedure, are not suggested in Geusic. Furthermore, as explained above, Hishiya is not directed to bonding wafers, and one of ordinary skill in the art of bonding wafers would not look to Hishiya to improve the bonding process or to improve the bonding qualities of the surfaces to be bonded.

With respect to claim 14, there is no indication in any of the references that conducting the recited steps in a single container could increase the bonding strength to the recited range. With respect to claim 20, as explained in the application, the resulting dry hydrophilic surfaces bond particularly well to each other, and when the HF bath followed by the ozone exposure are done in the same container, a uniform distribution of silanol sites can be formed, which will react with the silanol sites of the other substrate surface to form siloxane sites (application, paragraph 5, page 6). These have very elevated bonding strength compared to Geusic, and providing two substrates prepared by the same method, thus can obtain a different and stronger structure within the bond, than just preparing one of the wafers. Consequently, claims 13, 14, 16, and 20 are patentably distinct over the references of record.

Claims 1-5, 11-12, and 25 were rejected under 35 U.S.C. 103(a) as being obvious over Wu in view of Hishiya. Wu discloses a process in which etching solutions remove oxide, and then an oxidant comprising gaseous or aqueous ozone is used to remove patterned photoresist and a second oxide layer is grown. (*See* Wu [0009] and [0013].) Not only is Wu, like Hishiya, not conducted to improve the bonding characteristics of a surface, but after the Wu treatments, the surface would not have improved dry hydrophilic surfaces that could improve bonding, in part because the photoresist that is removed is patterned and the second oxide layer is formed on the portions that were exposed by the etch.

There is no suggestion of the present invention in Wu, and no combination thereof with Hishiya would produce the claimed method. There is also no motivation to use Wu to improve the bonding qualities of a surface or to combine Wu with another reference to provide such improved surface qualities. Thus claims 1-5, 11, 12, and 25 are patentably distinct thereover.

Claims 13-24 were rejected under 35 U.S.C. 103(a) as being obvious over Wu in view of Hishiya, in further view of Geusic. For the reasons explained above, no combination of the above references suggests a method with each and every element that is claimed, and Geusic does not provide the missing suggestion of the claimed steps.

Furthermore, there is no motivation in Wu or Hishiya to improve bonding qualities of a surface, and Geusic does not provide the motivation to modify disclosures that serve to provide oxide layers in order to be able to make a better bonding-surface. Consequently, claims 13-24 are neither taught nor suggested by any possible combination of the references.

Claim 26 further recites that the process is conducted within a closed container to uniformly saturate the substrate surface with oxygen. As discussed above, the references of record do not provide a teaching or suggestion of providing the closed container in which both the hydrophilic acid solution bath and the gaseous ozone atmosphere are contained, or that this would produce a surface that is uniformly saturated with oxygen, since the prior art methods are at far greater risk of contamination, and would require a much more complex process to obtain the elevated level of uniformity. Claim 27 recites that the ozone atmosphere uniformly saturates the substrate surface with silanol sites, and that the surface is bonded to another surface that is also uniformly saturated with silanol sites. The references do not provide any suggestion on this method or on the surprising advantages provided by the simple manner in which the highly uniform surfaces are obtained and of the improved bonding that is provided thereby. Similarly, claim 28 recites preparing first and second substrates by the method of claim 2 and bonding them together, which, for the reasons explained above, is also neither taught nor suggested by the prior art of record.

In view of the foregoing, it is believed that the entire application is now in condition for allowance, early notice of which would be appreciated. Should the Examiner not agree, then a personal or telephonic interview is respectfully requested to discuss any remaining issues in an effort to expedite the allowance of this application.

Respectfully submitted,

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